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## SECTION OF GEOLOGY AND MINERALOGY

FEBRUARY 6, 1939

PROFESSOR PAUL F. KERR, Department of Geology, Columbia University: *A Decade of Research in the Clay Minerals.* (This lecture was illustrated by lantern slides.)

Doctor Paul MacClintock, of Princeton University, was scheduled to give an address entitled, *"Weathering of the Glacial Till in New Jersey,"* but illness prevented his attendance. Professor Kerr generously served as a substitute in Doctor MacClintock's stead and delivered an excellent lecture, title as given above. No abstract was received.

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## SECTION OF BIOLOGY

FEBRUARY 13, 1939

PROFESSOR LORANDE LOSS WOODRUFF, Professor of Protozoölogy, Yale University: *Some Pioneers in Microscopy, with Special Reference to Protozoölogy.* (This lecture was illustrated by lantern slides.)

Although the science of optics formally starts with Euclid, there seems to be no evidence that the possibilities of a lens as an optical instrument were appreciated until toward the close of the thirteenth century. Roger Bacon suggested the value of lenses for persons with weak eyes, but apparently made no significant advance in the theory or the use of lenses. The actual invention of spectacles followed shortly after and their use gradually spread over Europe during the fourteenth and fifteenth centuries.

Then Leonardo da Vinci considered lenses, and the sixteenth century saw their optical properties studied in particular by Leonard Digges and Francesco Maurolico, while Giambattista della Porta made the earliest significant suggestion of a bilenticular system for the magnification of small objects. Near the turn of the century came the first feeble impact of lenses on biology at the hands of Thomas Mouffet, George Hoefnagel, and Fabio Colonna, just as the compound microscope was about to be invented by Zacharias Jensen. Galileo in 1610 was the first to use the instrument effectively and he introduced it to his colleagues in that coterie of scholars, including Cesi, Colonna, Stelluti, Fontana, Faber and Porta, meeting as the Accademia dei Lincei. The first figures ever made with the aid of a compound microscope to appear in a printed book were by Francesco Stelluti in 1630.

Probably the most important gleanings with the microscope during the next half century were those by Giambattista Hodierna and Francesco Fontana, while the instrument was exploited by Athanasius Kircher without giving detailed

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descriptions or figures of anything that it had revealed to him. Then a gifted physician of Paris, Pierre Borel, made a long series of observations and published in 1656 the first volume solely devoted to microscopy. And furthermore, he employed the instrument in his profession; probably the first practical use of the microscope in medicine. But an Englishman, Robert Hooke, was the first to realize to the full the importance of using instruments which increase the powers of the senses in general and of vision in particular, and to express it convincingly in 1665 in a remarkable book: *The Micrographia.* Here he described and emphasized for the first time the "little boxes or cells" of organic structure and indelibly inscribed the word *cell* in biological literature.

*The Micrographia* had an immense influence on microscopy, gleanings from its wealth of plates "embellishing" technical and popular manuals on the microscope for upward of a century. When the book was being written, Samuel Pepys purchased a microscope and thought five pounds, ten shillings "a great price for a curious bauble." And it is not recorded that Hooke's demonstrations, or those of the contemporary London physician, Henry Power, changed his opinion, but from this time on magnification was firmly established as an indispensable aid in biological research. The so-called classical period in microscopy unfolds during the latter part of the seventeenth century with the outstanding contributions of Malpighi, Grew, Swammerdam, and Leeuwenhoek—the latter the founder of protistology.

Antony van Leeuwenhoek enlivened every drop of water by his placid observations with simple microscopes made by his own hands. In 1674, while examining some pond water, he discovered, as he said, "very many little animalcules . . . the motion of most of these animalcules in the water was so swift, and so various, upward, downwards, and round about, that 'twas wonderful to see; and I judge that some of these little creatures were above a thousand times smaller than the smallest ones I have ever yet seen, upon the rind of cheese, in wheaten flour, mould, and the like." Two years later he gave

the first description of an identifiable Protozoon and also discovered Bacteria in pepper-water. He says, "the fourth sort of little animals . . . were incredibly small; nay, so small, in my sight, that I judged that even if one hundred of these very wee animals lay stretched out one against another, they could not reach to the length of a grain of coarse sand." Later he discovered several parasite Protozoa in man and beast, and Bacteria in the human mouth. Of course Leeuwenhoek made many other discoveries during his long life—his studies were not confined to animalcules—but it is enough that he is justly regarded as the Father of Protozoölogy and Bacteriology.

Leeuwenhoek complained: "I ofttimes hear it said that I do but tell fairy-tales about the little animals," but confirmation soon came. Hooke demonstrated animalcules in pepper-water at a meeting of the Royal Society in 1677, and the following year wrote that he had "discovered vast multitudes of those exceeding small creatures which Mr. Leeuwenhoek had described. . . . I was very much surprised at this so wonderful a spectacle, having never seen any living creature comparable to these for smallness: nor could I indeed imagine that nature had afforded instances of so exceedingly minute animal productions." The same year Christiaan Huygens described several animalcules familiar to Leeuwenhoek, in a letter which, indirectly, soon reached him but was not published until recently. Then thirteen years later Bonanni's *Observationes circa Viventia* appeared with the first published figures of ciliates, and was shortly followed by a series of papers in the Philosophical Transactions: King's *Several Observations and Experiments on the Animalcula in Pepper-water,* Harris's *Some Microscopical Observations of Vast Numbers of Animalcula Seen in Water,* Gray's *Several Microscopical Observations and Experiments,* and an anonymous contributor's letter which says, "I know many question the sincerity of his (Leeuwenhoek's) relations, but I can do him the right to affirm that as far as I am able to follow him, and I have tried many of his experiments, I find him always faithful in matter of fact, and therefore question not his veracity in other things."

So under Leeuwenhoek's stimulus by the turn of the century the world had become conscious of a microcosm below the limits of unaided vision. Then in 1718 appeared the first special treatise on the Protozoa and other tiny organisms by Louis Joblot of Paris. This is a remarkable and curious book that describes new microscopes and many new forms of animalcules, and makes the first general attempt to give the latter appropriate names. Furthermore, in the study of the origin of the organisms, Joblot was the first to boil infusions in order to eliminate life; a method exploited in studies on biogenesis by Spallanzani and others a half century later without a thought of Joblot.

The next significant contribution was made by Dr. John Hill in 1752, who gave the first formal classification of animalcules, including them in the Animal Kingdom as the most primitive group. He says that he "arranged them into a regular method, and gave them denominations"—one the now familiar *Paramecium.* Linnaeus in the twelfth edition of his *Systema Naturae* grouped all of them under three genera: *Volvox, Furia,* and *Chaos,* and all the infusoria in a single species, *Chaos infusorium.*

Obviously an immense field awaited intensive study, and this was begun in a desultory way by many amateur and professional biologists during the closing decades of the eighteenth century, the outstanding contributions being made by O. F. Müller in 1773 and 1786. And then over a half century passed before Ehrenberg in 1838 and Dujardin in 1841 afforded a sufficiently broad view of these "simple" animals to justify the establishment of the phylum Protozoa by von Siebold in 1845. Thus the development of Protozoölogy exemplifies the dictum of an early microscopist that "the likeliest method of discovering the truth is the observation of many on the same subject," but surely none of the pioneers even dreamed that studies by their twentieth century disciples would indicate that there are more species of Leeuwenhoek's "little animals" than comprise all the rest of the Animal Kingdom.

## SECTION OF PSYCHOLOGY

FEBRUARY 20, 1939

DOCTOR CLARK L. HULL, Institute of Human Relations, Yale University: *Modern Behaviorism and Psychoanalysis.*

Behaviorism and psychoanalysis are generally regarded as independent disciplines, yet both concern the behavior of the same organism—man. Presumably the same ultimate laws underlie all of human behavior. When these are known and their implications fully elaborated we shall have an integration of the social sciences. A major task in such a development will be to integrate whatever truth lies in behaviorism and psychoanalysis. Moreover, the integrational process will tend powerfully to fill in gaps and correct errors in both disciplines. The first step in this integration is to identify the numerous equivalent concepts and behavior principles existent in the two disciplines but now hidden under differences in terminology. The present paper presents a tentative and partial statement of such equivalences.

Perhaps the most primitive and basic notion in psychoanalysis is the *id.* To a behavioristic analysis this concept appears to be the basic physiological source of drives together with a reification of the fact that conditioning or reinforcement occurs, presumably according to the "law of effect."

A central and closely related concept of psychoanalytic theory is that of *libido.* In a behavioristic system this appears to correspond to a generalized or undifferentiated drive with special emphasis on "pleasure." The extent to which the various drives recognized by academic psychology are actually generalized remains largely unexplored. We do not know, for example, to what extent habits set up on the basis of one drive will function on the basis of others; nor to what extent satiation of one drive will weaken the others.

Closely related to the concept of the id and of the libido is that of *object cathexis.* Cathexis appears to be the result of a

conditioning process whereby organisms acquire the tendency to seek or strive to attain goals or subordinate goals. Object cathexis may now be derived quite nicely from behavior theory. Involved in this derivation is the principle of response equivalence, *i.e.,* alternative reactions leading to the same goal (reinforcing state of affairs).

Behavioristic analysis indicates not only that there is a considerable variety of objects which will mediate reinforcement of acts leading to the satiation of the various drives, but that these objects present a natural hierarchy in respect to their reinforcing potentiality. It is also to be noted that at the different ages of childhood there is a progressive enlargement in the number of objects which are physically and socially available for libidinal reinforcement. It thus comes about that while the objects sexually cathected are to a considerable extent a matter of chance, there is nevertheless on the average a definite tendency to an orderly sequence in object cathexis. Thus it is inevitable that if sexual cathexis in an infant occurs, it will be to its own body; at this age sexual activity can only take some very simple form of masturbation such as thigh rubbing. This type of sexual goal seeking necessarily becomes centered in the subject's own body; when generalized, psychoanalysis calls the resulting habit organization *narcissism.*

As the child grows older chance may bring it about that the object cathected is a playmate of the same sex; thus naturally would arise one type of *homosexuality.* But a person of opposite sex usually has a higher place in the hierarchy of reinforcing agents than one of the same sex. It thus comes about that, except for anxiety potentials, the person usually cathected in the end is a person of opposite sex; this results in *heterosexuality.* However, inanimate objects may be cathected, in which case we have *fetichism.* In some Russian breeding experiments, stallions have been taught to copulate with an inanimate apparatus for which they will strive violently. A more complex situation is that in which a man will have a sexual craving to possess a bit of feminine underwear. This shifting

from one sexual goal object to another is known in psychoanalysis as *transference* of the libido.

It sometimes happens that the conditioning to a given goal object may be too strong; animal experiments show that this may interfere with the conditioning to a new goal object. Thus arises one form of what psychoanalysis calls a *fixation.* Extreme fixation prevents further transference. But even if the organism has transferred or shifted upward through the hierarchy of goal objects successfully, animal experiments seem to show that if a severe frustration or emotional shock occurs, the organism may revert to a previously abandoned type of goal. In psychoanalysis this is called *regression.* Sometimes, however, the emotional shock may be so profound that its generalized effects extend from the goal in which the trauma occurred to practically all such goals; this is known in psychoanalysis as one form of *repression.*

In the process of trial-and-error characteristic of life, two rather different types of action are followed by reinforcement. Approach behavior is one such type. When generalized in social situations this is called *love.* In other (injurious) situations the separation of the organism from the situation is reinforcing. This separation may be effected by (1) the flight of the organism or (2) by the removal of the critical element in the situation. The state of the organism in the former situation is called *fear.* Vague, persisting anticipatory fears are called *anxiety.* The organism learns by trial-and-error that other (offending) organisms will remove themselves when attacked: thus *aggression* is reinforced. Persisting impulses to aggression are called *hate.* Sometimes through previous conditioning, the same person may have an excitatory potentiality for both love and fear or for both love and hate: psychoanalysis calls this *ambivalence.*

When we have no functioning verbal reactions conditioned to a past situation or present intent ($r_G$) we obviously cannot tell about it. Such events and motivations are said by psychoanalysis to be *unconscious,* whereas when we can tell about

them they are said to be *conscious.* Since children have few words before three or four years of age, it is inevitable that they should not be able to tell about events of that period, yet lasting habits, including toilet training, are formed at this time. These events are naturally "unconscious."

Through the "law of effect" the organism learns by trial-and-error that words originally used in communication may be used as *pure stimulus acts* to mediate purely individual problem solution. The complex organization of symbolic habits for the purpose of thought and reasoning appears to be substantially what psychoanalysis means by the term *ego.* Since this is all verbal it follows (1) that the ego is highly conscious, and (2) that it is highly intelligent (as contrasted with the unconscious).

In the early years of a child's life, much of conduct is usually motivated through punishment or threats on the part of parents and teachers. Partly because of the early age when these habits were set up, they are not verbalized. For this reason the subject usually can not tell why such acts are performed or why contrary acts give rise to anxiety. The mass of such habits apparently makes up what psychoanalysts call the *super-ego,* and what usually is known as conscience. The anxiety arising from the violation of such habits we call the "pricking of conscience." The lack of verbalization of such habits seems to be the substance of what is known as *internalization.*

In the disciplinary situation a person usually learns to escape punishment for previous acts by ingenious word sequences which may not correspond to fact but nevertheless are often reinforced according to the "law of effect." In a similar manner by trial-and-error a person may by a certain word sequence relieve himself of anxiety occasioned by an act in violation of the super-ego. The word sequences may be contrary to the logic of the ego system but its subvocal execution will be reinforced, nevertheless: this is called *rationalization* by psychoanalysis.

As a last conceptual equivalence we take the case where a person with a heavy load of anxiety finds through trial-and-error that it is reduced, though but temporarily, when he performs some special act. This act may be appropriate enough where it first occurred. Nevertheless the law of effect will reinforce it and it will continue to recur in all sorts of inappropriate situations as well. The patient's acquaintances will regard him as strange or neurotic, and the odd behavior will be regarded as a neurotic symptom, as indeed it is. This is a behavioristic rendering of perhaps the most important single psychoanalytic principle, that of *symptom formation.*

## SECTION OF ANTHROPOLOGY

FEBRUARY 27, 1939

DOCTOR HERBERT J. SPINDEN, Curator, American Indian Art and Primitive Cultures, Museum, Brooklyn Institute: *The Archaeology of the Northern Andes.* (This lecture was illustrated by lantern slides.)

In the hope of finding evidence that a cultural highway ran in ancient times from Mexico to Peru—from one area of really high civilization in aboriginal America to the other—I spent nearly six months in traversing Colombia, Ecuador and Peru under the auspices of the Brooklyn Museum. The plan was to enter little known but strategically located regions off the main routes of travel, making photographs, drawings, etc., of the archaeological objects found in private cabinets and local museums, also visiting such ancient sites as could be reached without great loss of time.

Actually the lion's share of attention went to Colombia, a large and diversified country that archaeologically has been reported on in a very imperfect way. Bogotá, its capital—which last year celebrated its four hundredth anniversary as an outpost of Europe and which before 1538 was the head of the Chibcha state—lies about midway between those two famous lakes of Texcoco and Titicaca on whose shores flourished the Aztecs and the Incas before their careers of empire were likewise cut short by the Spanish conquest. A stretch of four thousand miles of rough mountain trail separates the two ends of this archaeological quest. Whereas, only a few years ago we despaired of finding definitive evidence of broadcast exchange in ideas and products over this really great distance, today the final proof seems well within our grasp. Several important techniques in art are now known to be distributed over this long trail, such as:

(1) Painting with wax and with black and red pigments to give negative designs on pottery.

(2) Covering surfaces of gourds and of wooden and pottery vessels with a sort of lacquer in bright inlaid colors.

(3) Covering objects of carved wood, of shell, bone, etc., with an inset mosaic of bits of jade, jasper, turquoise, vermillion colored shells, etc.

(4) The handling of several metals by the lost wax method of casting and the filigrane method of designing.

(5) The use of flat and cylindrical stamps for transferring designs to the body or to textiles.

(6) The use of marcasite mirrors, of clay whistles with four notes, of large conch trumpets, of looms and spindle whorls, etc., etc.

All of these technological concepts can be demonstrated as passing from Mexico to Peru. Here we are only on the threshold of our studies; for motives in religion and art have a similar distribution down the Sierra Madre and down the Andes: the Sky God as a jaguar; the Sun as a disk with serpent rays and containing the face of this jaguar god; the humanization of sea snails, crabs, centipedes, scorpions, etc., as patrons of various special abilities; the humanization of eagles and several other animals as the patrons of warrior societies making head-hunting warfare. All of these and numerous motives in decoration, numerous domesticated plants, now constitute a mass of visual evidence documenting the flow of ideas along the mountain road from Mexico to Peru. This interchange over such a great distance was made through numerous self-governing tribal societies each with its own stamp and personality, its own language and its own arts and ceremonies.

Special attention will be paid to several culture areas, especially in Colombia. I will not do more than briefly mention the Tairona culture area in the vicinity of Santa Marta, my port of entry, and the locality in which my investigations began. Here several cemeteries have been excavated by J. Alden Mason, the results indicating a community of ideas with parts of western Venezuela. Nor will I devote much time to the

Chibcha, of the high central plateau, or to the Quimbaya, on the middle course of the Cauca, for their products have long been well known, thanks to the works of Vincente Restrepo and his son, Ernesto Restrepo Tirado, to mention only two of the scholars of Colombia.

I do wish, however, to direct attention to the region between Cartagena and the Gulf of Urubá, the seat of three little kingdoms or queendoms called Zenu, Panzenu and Zenufana, occupying the region of the Sinu River and of the San Jorge to the south. This was the first part of the American continent to feel the impact of Spanish arms. From the Sinu area was taken the heaviest loot of the New World and by 1530 practically all the cemeteries had been dug up by Spanish armies for the golden treasure buried with the dead. The few specimens of ceramic art which have survived are really superb and the same can be said of surviving examples of their gold jewelry.

The culture of Sinu may have been sybaritic and ultrafeminine for two of their governments had queens. In the ceramic art women are delightfully and smilingly portrayed and the female breast is represented in lobed pots, etc. According to the stories told by the first Spanish adventurers women rulers of the Sinu had rich palaces and had a special manner of climbing into their hammocks. These were supported by carved poles covered with gold. When the time came to retire a living ladder was formed on the bodies and shoulders of ladies in waiting.

The cemeteries of the Zenu were high earthen mounds over platforms and they were called "piru," clearly the origin of the present name "Peru." I visited a site near Lake Betanci south of Monteria where graves were opened some 25 years ago. In one grave 27 pounds of gold was found, and in others lesser amounts making up a total of about 100 pounds for the two mounds of Maracaybo and Flamenco. Burial seems to have been by cremation and both the jewelry and the bones were burned or blackened with fire. A certain Gusimindo

Montoya, a huaquero, had found these surviving tombs, selling the gold as metal.

Our professional pot hunter is represented in Colombia by the *huaquero,* a person who deals in *huacas,* the latter being the Peruvian word for an Indian grave and any object that comes out of it. Of course the huaquero is really looking for gold and all too frequently he finds it and melts it down. This is an ancient and officially honorable profession for the first huaqueros were the first Spaniards who landed in Colombia. According to the Colombian mining law it is permissible to make a gold claim on any ancient Indian site—*patio de Indio,* they call it—whether on public or private land. A double tax must be paid on such treasure trove.

Very different kinds of archaeological remains are found in the middle portion of the valley of the Magdalena. There are cylindrical funeral urns sealed with asphaltum on the tops of which are male and female figures modeled in a style that may be called late Archaic. No gold is found in these tombs which are obviously of earlier date than the Sinu mounds. We are concerned with secondary burial for the bones are fragmentary even in the sealed urns and the skulls are stuffed full of the small finger and toe bones, a condition which could not occur with primary burial. We are confronted with an aspect of the American Indian cult of the dead of exceptional interest the meaning of which can only be inferred. For instance there is no label instructing that the "bones be reassembled and the personality restored according to the sculptural sample."

In recent years the Colombian government has itself fostered important archeological research especially at the famous site of San Augustin with its many remarkable statues and in the closed valley of the Paez River called Tierradentro—the Inside Country—where rock-cut tombs with columns, niches and with painted walls and ceilings have been brought to light. Stone statues have also been found here as well as noble examples of gold work such as a gold mask representing a jaguar's face. This Colombian research has extended over

the Chibcha territory and into a new archeological province called Calima, centering around the site of the original Cali. Here pottery and gold work sufficiently distinct from that of the Quimbaya has been unearthed. The gold work of this Calima culture, which extends as far south as Popayan, shows a composite animal subject probably to be interpreted as a Sky God. In a collection of Guillermo Valencia, the dean of Colombian poets, there are remarkable figures in clay showing such a god seated on an elaborate stool.

Beginning with Pasto we enter a province of archaeology extending well into Ecuador. Here are found magnificent examples of negatively painted urns with designs that picture the disk of the sun and also the jaguar among the stars.

Finally I refer to the culture of Esmeraldas in northwestern Ecuador. The archaic technique of modelling figurines here appears almost as it does in Mexico. Later and more developed is a rich art with unmistakable Maya contacts. Here the animal god with a human face peering out of the open mouth is clearly seen, this being one of the outstanding conventions of Central America. Access to the humid coastal region of Esmeraldas can be had from the flanks of the Andes by the now unhealthful valley of the Patia. In Ecuador and Peru it seems probable that various parts of the coast must have received their first civilized population from the inter-Andine valleys. To the north in Colombia it seems to me that the Cauca was a more important highway than the Magdalena.

## SECTION OF PHYSICS AND CHEMISTRY

### FEBRUARY 24 AND 25, 1939

*Conference on "Kinetics in Solution"*

The Section of Physics and Chemistry held a "Conference on Kinetics in Solution," the second of a projected series. Professor Victor K. LaMer, Columbia University, was in charge of this meeting as Conference Chairman.

The program consisted of the following papers:—

"The Effect of Solvents on Reaction Rates," by Professor Henry Eyring, Princeton University.

"Relation of Temperature Coefficients in Solvents at Constant Composition to that in Solvents at Constant Dielectric Constant," by Professor J. C. Warner, Carnegie Institute of Technology.

"Prototropy and Deuterotropy in Pseudo Acids," by Professor S. H. Maron, Case School of Applied Science.

"Kinetics of Oxygen Exchange Reactions," by Doctor Irving Roberts, Columbia University.

"Acid-Base Catalysis," by Doctor F. H. Westheimer, Chicago University.

"Kinetics of Walden Inversion," by Professor L. P. Hammett, Columbia University.

"Ionization Mechanism of Solvolytic Reactions," by Doctor Paul D. Bartlett, Harvard University.

The third Conference in this series will be held on April 14 and 15, on the subject of "Dielectrics," and will be under the guidance of Professor C. P. Smyth, Princeton University.